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Pest Control and Pesticides

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Comments on . . . .

JULY, the month of conferences, conventions, demonstrations and shows. We pass from eddy to eddy in a whirl of activity which leaves the head reeling from the non-stop bombardment of facts and figures, discussion and argument. Many will have some interest in the majority of these functions. By sticking to a tight schedule it is sometimes possible to attend all the meetings that are of interest to you but at a cost. On returning to the office you come face to face with a mass of routine work which has piled up in your absence. Once more Organising Secretaries will be urged to collaborate to avoid the overlap of conventions and shows.

This seems to be a simple straightforward answer to the problem but then we do not have to look far to find a simple answer to many problems. For example the threat of a nuclear war and the associated terror of radio-active fallout can be averted by the simple expedient of 'banning the bomb'. The seething, striving mass of metal and man which turns the peak hours into chaos can be turned into a smooth and orderly flow by simply staggering working hours or, better still, by abandoning the traditional weekend. Take any problem, particularly an administrative one, and you can be pretty sure that someone will be able to provide you with a simple straightforward answer. You may even be lucky enough to find someone wise enough to devise a means of putting the scheme in operation but to carry it through to the ultimate goal you will need the wisdom of Solomon and the crowd swaying power of Hitler.

We can be sure that Organising Secretaries have heard the arguments for staggering conferences on numerous occassions but unlike many of their would be advisors they also know the difficulties involved. We wish them the best of luck in their thankless task and if they do anything to remove the July jam we will be most grateful.

Safety

The safety aspects of pesticide application arouses more discussion and argument than all other aspects put together. Anyone may be drawn into such arguments and if they wish to know something of the subject they may like to consider the following views which have recently been expressed.

" The safety record of the newer compounds (pesticides) is good in the U.S. and several other technically advanced countries largely because of careful labelling. In countries where labelling is poor or where illiteracy or irresponsibility tend to vitiate labelling, hundreds of cases of human poisoning have occured. Because of the usefulness of economic poisons in the control of vector borne diseases and a wide range of agricultural pests, it should be our purpose to improve the safety of all pesticides, both old and new, in all countries, in order that their benefits may not be compromised.

"........there is nothing to be gained in the long run by irresponsible statements that nothing now is known of the toxicology of the newer pesticides, or that no legal control of their use exists, or—in the absence of epidemiologic proof—that a wide variety of illnesses from which mankind has suffered for generations is now caused by intoxication by the newer economic poisons."

(*By Wayland J. Hayes Jr., Communicable Disease Centre, Savannah as a conclusion to his article "Pesticides in relation to Public Health"*, Ann. Rev. Ent. Vol. 5 pps. 379-404).

"A human would have to eat 15,000 pounds of contaminated cranberries a day for many years to approximate the dosage and conditions under which thyroid tumours were observed to develop in laboratory rats."

(*Quoted on the "Cranberry Scare" from the booklet "Pesticides and Public Policy" published by the National Agricultural Chemicals Association of America.*)

Other recent publications dealing with safety include "Pesticides" *Safety Standards* **9** (1), 7,9,19,20, published by the U.S. Dept. of Labour and "*Report of the Panel on Food Additives*" issued by The President's Science Advisory Committee On the Use of Food Additives and Pesticides, Washington 25, D.C., this latter report is the result of an investigation into the relationship between pesticides and cancer, and despite the eminent scientists and experts serving on the panel only serves to show how little is known of the causes of cancer.

A NEW TECHNIQUE for ERADICATION OF TIMBER PESTS

By
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R.E. (T.D.)

A novel type of wood preservative formulation, Woodtreat, enables timber to be deeply and evenly impregnated by means of a single surface application. Its use provides a new technique for eradicating insect and fungus pests from infested timber. Laboratory and field experiments are described. Trial quantities are now available for professional evaluation.

THE effectiveness of any wood preservative is governed by the extent to which it penetrates wood and its concentration in the area penetrated. This applies not only to preservatives used for treatment of new timber, but also to preservatives applied to infested timber to eradicate insect pests or wood rotting fungi. The aim of eradicant or curative treatment is to kill insects or fungi at work in the infested wood, and at the same time, to prevent further attack. Clearly, a technique whereby a preservative can be applied to the surface of timber *in situ* and penetrate in force and in depth is of the greatest interest, especially as the practice is growing in the United Kingdom of curative treatment companies giving householders a guarantee that timber treated by them will not be reinfested for a considerable number of years.

Woodtreat

This novel type of preservative, developed in the U.S.A. and patented, enables timber to be penetrated deeply and evenly with large quantities of preservative from a single surface application. It consists essentially of an organic solvent type preservative made into the form of a bodied, gel-like, mayonnaise-type emulsion (Fig. I). Woodtreat sustains itself on the surface of the wood (Fig. II) and can, therefore, be applied as either a complete coating covering all accessible surfaces or as bands or ribbons. It provides a reservoir on the surface of the wood from which the active ingredient in the oil phase can be absorbed by the wood over a period of time.

*—*This paper is based on a lecture of the same title presented to Members of The Industrial Pest Control Association on the 24th of March,* 1960.

It is believed that after application a film forms over the surface of Woodtreat exposed to the air, through which water vapour from the continuous phase of the formulation, but not from the less volatile disperse oil phase, evaporates. As the water leaves, the droplets of the oil phase gather together and soak into the wood taking with them the dissolved pentachlorophenol. The rate of absorption will of course be governed by such factors as the intrinsic permeability of the species of wood, the amount of sapwood present, the moisture content of the wood, the presence and extent of fungal infection and so on.

Penetration and Absorption Tests

Woodtreat may be looked on as a means of applying many brush or spray coats with a single application or, alternatively, and more accurately, as a way of immersing *in situ* timbers in preservative since the essence of dip treatments is to surround the timber with preservative so that it can absorb as much as possible in its own good time.

Van Allen (1956) carried out tests comparing depths of penetration and retentions of Woodtreat TC with a conventional organic solvent type preservative containing pentachlorophenol. Three species of timber were used:-

Southern yellow pine	.. *Pinus palustris* and closely related species
Douglas fir ..	.. *Pseudotsuga taxifolia*
and	
Red Oak ..	.. *Quercus rubra*

The sapwood of *P. palustris* is permeable but the heartwood is resistant. Red Oak is resistant to preservative treatment. Douglas fir is notoriously difficult to penetrate with preservatives even by vacuum/pressure impregnation.

In all cases clear, matched specimens, 2"×8"×24" of average density were used. The mositure content of the wood ranged from 10% to 14%. When end grain penetration was studied the sides of the specimens were sealed with three coats of an aqueous dispersion of polyvinyl acetate and when side grain penetration was studied the end grain was sealed in the same way. Brush applications of the organic solvent type preservative were applied at a rate of two a day with an eight hour interval between them. Woodtreat was applied as single coats of various thicknesses. Thirty days after application, specimens were sectioned and analysed for pentachlorophenol by the lime-ignition method. In the case of specimens treated with Woodtreat the surfaces were scraped and brushed prior to analysis to avoid surface residues being erroneously recorded as penetration. The results are given in detail in the original paper.

The salient points, however, are brought out in histograms prepared from them (Figs. III, IV and V). In preparing the histograms, pentachlorophenol retentions for Woodtreat TC, which contains 8.7% wt/wt pentachlorophenol, has been corrected to a 5% basis to give a true comparison with the 5% wt/wt pentachlorophenol solution used for brush treatments. It will be seen from the histograms that a single overall application of Woodtreat penetrated deeper and produced higher retentions of pentachlorophenol than did 20 brush coats of a conventional organic solvent type preservative.

In our own laboratories, tests comparing the penetration of Woodtreat with organic solvent type preservatives have been carried out using blocks of redwood, *Pinus sylvestris*, as described by Purslow (1958).

The blocks were cut from a length of wood selected for its straight grain and freedom from knots. The wood included pith, heartwood and sapwood. Before treatment with preservative, the ends of the blocks were sealed with three coats of heat-treated "Epikote" resin to prevent penetration through the end grain.

In the first series of tests, blocks 6 ins deep with a cross-section of 6 × 2½ ins. were used. Their moisture content determined by the oven dry method was 10%. The penetration of Woodtreat at various rates of application was compared visually with a 10 minute dip in petroleum distillate both distillate and Woodtreat being coloured green with an oil soluble dye. The treatments were as follows:-

1. Petroleum distillate applied as a 10 minute dip.
2. Woodtreat applied at a pre-determined rate of .. .. 1 lb./cu.ft.
3. ,, ,, ,, ,, ,, 2 lbs./cu.ft.
4. ,, ,, ,, ,, ,, 3 lbs./cu.ft.
5. ,, ,, ,, ,, ,, 4 lbs./cu.ft.

The Woodtreat was applied evenly to the tops, bottoms, and sides of the blocks as ribbons approximately 1/8 ins. wide and 1/8 ins. deep, but leaving a centre one inch gap so that when the blocks were subsequently bisected the pattern of penetration was not distorted by the saw blade passing through areas to which the emulsion had actually been applied.

After 48 hours all the Woodtreat applied at the 1 lb./cu. ft. rate had been absorbed and all surfaces were dry. At 2 lbs./cu. ft. most of the emulsion had been absorbed but the bottom of the block was still wet. At 3 lbs. and 4 lbs./cu. ft. not all the emulsion had been absorbed and some run-off had occurred. It was estimated that the final retentions in the two most heavily treated blocks were 2—3 and 3—4 lbs./cu. ft. respectively as a result. After five days all blocks were dry. Two weeks after treatment the blocks were cut across the middle and the cut surfaces were sanded and brushed with glue solution to reveal the pattern of penetration.

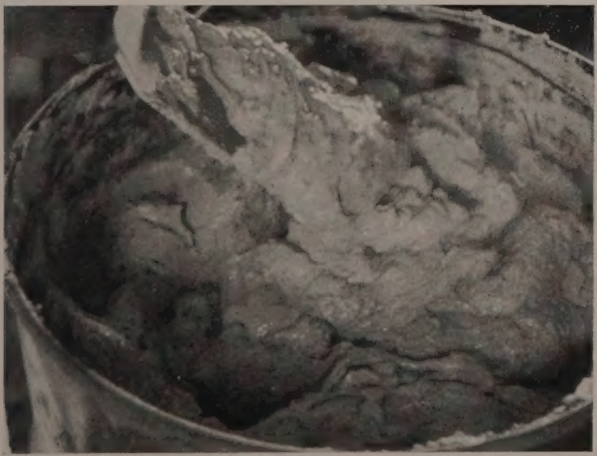


Fig. I. Woodtreat is in the form of a thick mayonnaise-type emulsion

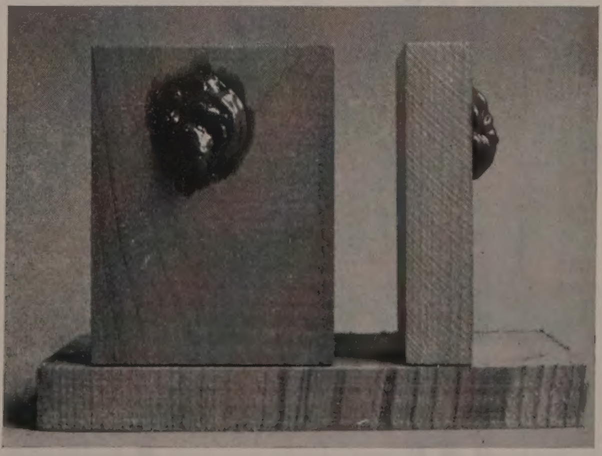


Fig. II. Demonstrating the self-sustaining properties of Woodtreat. A dye has been incorporated for contrast. Note on the left how Woodtreat begins to spread within a few minutes of application.

Histograms comparing the penetration of a single layer of Woodtreat ■ with a conventional Organic Solvent type preservative □

SOUTHERN YELLOW PINE — DOUGLAS FIR — RED OAK

Concentration of Pentachlorophenol (lbs. per square foot)

Fig. III. END GRAIN PENETRATION
Single ½″ layer of Woodtreat
20 brush coats of O.S. preservative

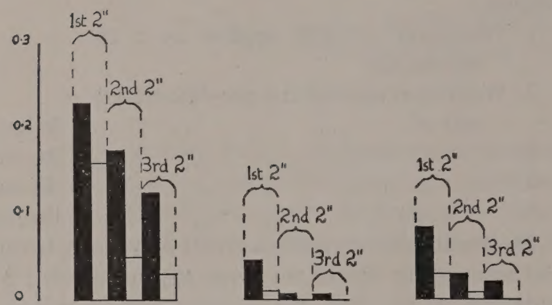


Fig. IV. EDGE GRAIN PENETRATION
Single ¼″ layer of Woodtreat
20 brush coats of O.S. preservative

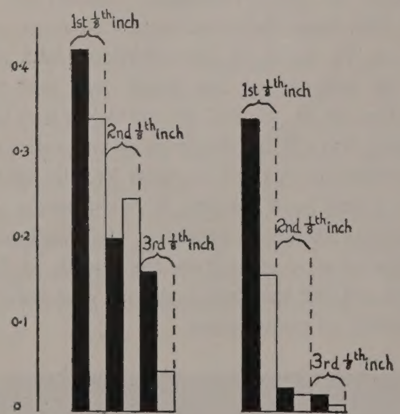
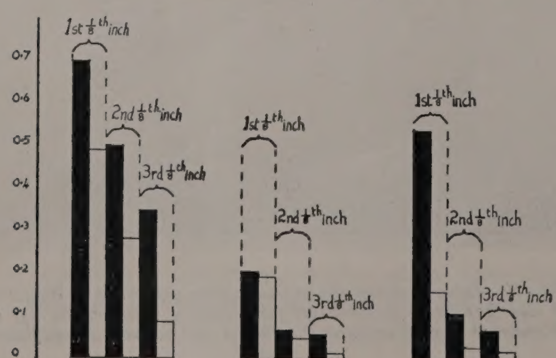


Fig. V. FLAT GRAIN PENETRATION
Single ¼″ layer of Woodtreat
20 brush coats of O.S. preservative



The results are shown in Figure VI. It will be seen that Woodtreat at 1 lb./cu. ft. gave a pattern of penetration similar to that of the block dipped in petroleum distillate for 10 minutes but with a most interesting and important difference. With the Woodtreat, the penetration is much more even and, in contrast to the dipped block, there is an absence of areas where there has been virtually no penetration and consequently no protection. Purslow and Smith (1960) have shown that application of two brush or spray coats of petroleum distillate or an organic solvent type preservative to the surface of rough sawn redwood produced absorptions similar to a dip of 10 minutes' duration.

With Woodtreat at the higher rate of application, almost complete penetration of the wood was obtained including the heartwood and pith and comparison of blocks 3 and 4 in Fig. VI with photographs in the paper by Purslow (1958) show a picture very similar to those for blocks soaked in organic solvent type preservative for 24 hours.

In a second series of tests using redwood blocks some quantitative results have been obtained by weighing the blocks before and immediately after treatment to determine the absorption of preservative. Fourteen days later the blocks were cut and the area of penetration was measured. This was done by tracing the limits of penetration on polythene sheet then placing this on squared paper to count off the area penetrated.

The blocks in this experiment measured $6 \times 2 \times 5$ in. Their moisture content was 15% and the proportion of sapwood in them was approximately 30%. Tests were carried out in duplicate. The results comparing penetration and absorptions of a single application of Woodtreat TC with a 10 minute dip application of Brunophen No. 2. and with two brush coats of Brunophen No. 2 and Brunophen R60 are given in Table I. The last two compounds are organic solvent type preservatives containing pentachlorophenol and dieldrin as the main active ingredients.

It will be seen from Table I that these results confirm the finding of Smith and Purslow (1960) that for redwood a 10 minute dip gives about the same absorption of organic solvent type preservative as two brush or spray applications. It will also be noted that more Brunophen R60 and Woodtreat was absorbed than Brunophen No. 2 and that Woodtreat penetrated farther than either of the other two formulations.

An important point mentioned in connection with the first series of tests but not brought out in Table I is that Woodtreat penetrates more evenly than either of the organic solvent type preservatives. Figure VII reproduces tracings of the cut surfaces of blocks treated by dipping for 10 minutes in Brunophen No. 2, brushing twice with Brunophen R60 and applying Woodtreat once as ribbons. It reveals quite clearly that Woodtreat penetrates more evenly and provides a complete preservative barrier

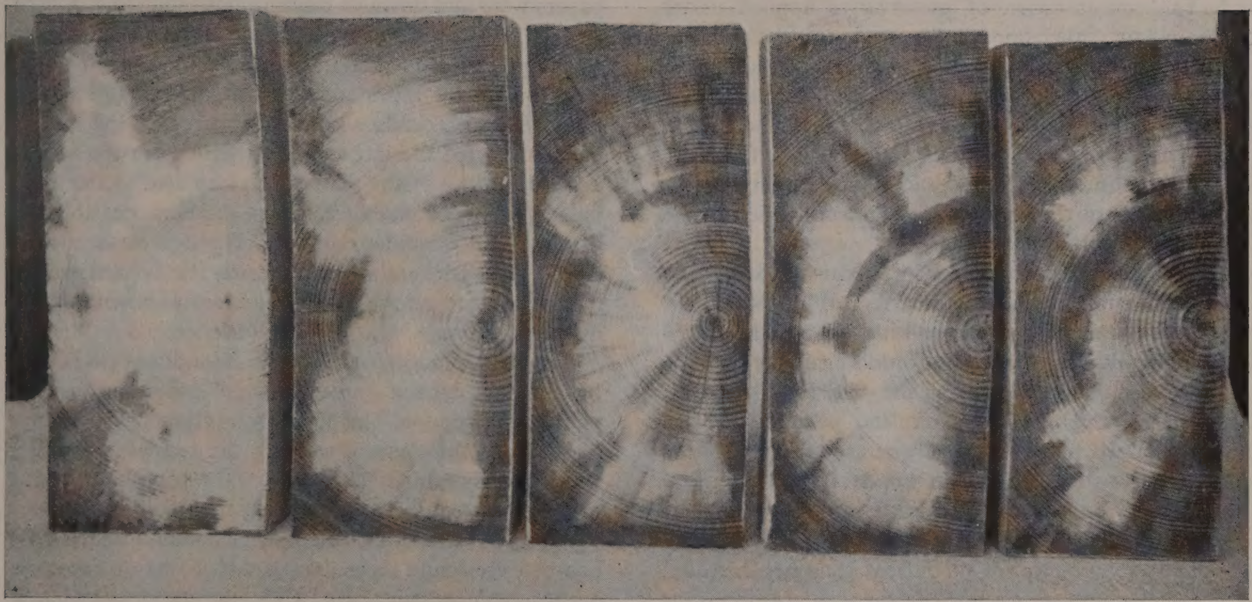
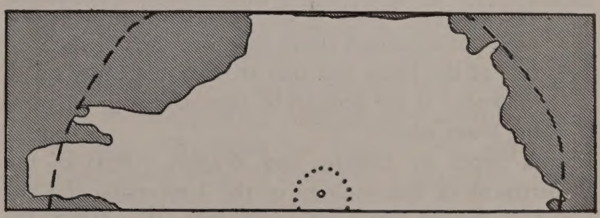
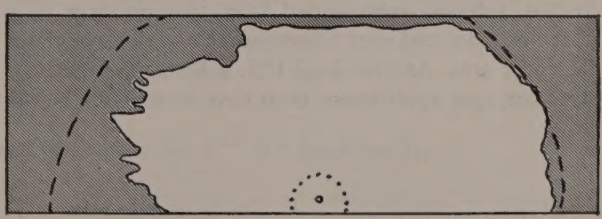


Fig. VI. (above) Series of blocks treated with dyed petroleum distillate and Woodtreat (dark) from left to right: 10 minute dip in petroleum distillate, 1lb/cu. ft. Woodtreat, 2lbs/cu. ft. Woodtreat, 2-3lbs/cu. ft. Woodtreat, and 3-4lbs/cu. ft. Woodtreat.

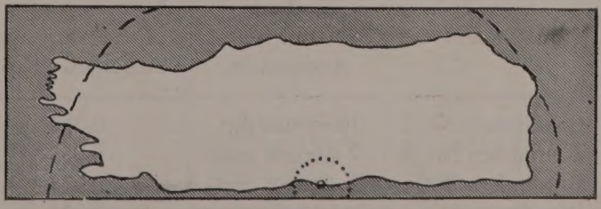
Fig. VII (right) Penetration of Woodtreat compared with organic solvent type preservatives.
Cross hatching: penetration of preservative.
Broken line: sapwood/heartwood boundary.
Dotted line: heartwood/pith boundary.



Brunophen No. 2 *10 minute dip*



Brunophen R. 60 *2 brush coats*



Woodtreat TC *One application as ribbons*

whereas the other treatments leave some areas only superficially protected.

It is proposed to carry out further experiments on these lines using various species of timber commonly used in new and old buildings. At this point it is worth mentioning that application of Woodtreat as ribbons on the heartwood top surface of an oak parquet strip penetrated to the sapwood under surface which was heavily infested with *Lyctus brunneus*.

Practical Trials with Woodtreat

Practical trials have been carried out in the United States and in this country, whilst others have been started in the Commonwealth.

Although a recent paper by Behr (1960) of the Department of Forest Products, Michigan State University, recommends Woodtreat for control of fungus decay, work in the U.S.A. has been concerned primarily with control of termites. Hatfield and Van Allen (1956) compared the distribution of preservative in Southern yellow pine of a surface coating of Woodtreat with a conventional organic solvent type preservative applied under pressure to holes bored in the wood—a method commonly used for termite control. Their tests showed:-

1. The concentration of preservative applied under pressure into bore holes produced the greatest concentration of preservative around the holes with practically no preservative reaching the outside of the timber except near the ends of the wood. Woodtreat worked in the opposite way, from the outside inwards, the depth of penetration being a function of the amount of emulsion applied to the surface of the wood.
2. Liquid applied to termite infested wood tended to follow the galleries and the rest of the wood got little treatment, whereas with Woodtreat distribution depended primarily on diffusion through the wood rather than through the galleries.
3. In 1″ thick wood complete penetration was achieved with Woodtreat, whereas drilling of such wood was impractical. In wood 2″ thick complete penetration could be obtained if its location permitted sufficient emulsion to be applied.
4. Diffusion patterns of Woodtreat in timber indicated that a complete surface coating was not necessary and that application as bands or ribbons has many advantages from a practical point of view. Experiment showed that application of ½″ thick bands at one foot intervals gave better treatment than drilling and injecting fluids. It also revealed that the bands need not approach closer than one inch to the topside of the joists and that they should taper off in thickness at the bottom to eliminate drip-off from the lower edges.

In a paper by Ebeling and Wagner (1959) of the Department of Entomology of the University of California, extensive practical trials with Woodtreat for control of drywood termites are described. The attics of 13 dwellings, the substructures of 4 and two garages were treated. Infested areas varied from two or three to a dozen or more and were sometimes scattered throughout the entire area. As from ¾—2 U.S. gallons were used per structure, spot applications must have been made. Newspapers were laid down to catch pellets indicating termite activity and the treated areas were inspected 1—2 months after the first application.

In four of the attics and in both garages pellets were found in appreciable amounts—"the result of incomplete survey of the infested areas before treatment was applied." More of the material was applied to the areas missed or inadequatley treated on the first occasion and in no instance were fresh falls of pellets subsequently discovered. The authors emphasize the advantages of this technique over the drilling and injection method and over fumigation.

The first practical trial with Woodtreat in Great Britain was carried out in a small office in business premises in London. The property was damaged by bomb blast during the war and when it was decided to instal a new filing system in a room on the top floor it was considered advisable to make sure the floor was capable of taking the additional weight. On examination, the floor boards were found to be damaged by common furniture beetle, *Anobium punctatum*, whilst the centre portions of four joists and the ends of two had suffered serious damage by wet rot probably caused by leakage of rain water after the bombing. The rot, however, was inactive and the joists were quite dry. The wall plates were sound.

The curative work consisted of:-

1. cutting away and removing the badly damaged portions of the old joists.
2. treating the remaining old joists with Woodtreat.
3. fixing five new reinforcing joists alongside those which were badly damaged, four of them being treated with Woodtreat and the fifth with Brunophen No. 2.
4. removing all old floor boards, levelling up and laying new boards treated with Brunophen No. 2.

Woodtreat was applied, using a flat piece of wood as a trowel, to the old joists *in situ* by a carpenter and his mate with no previous experience of the product. Four 7 ins × 2 ins. joists 12 ft. long and four joists 9 ft. long were

TABLE I

Penetration and Absorption of Woodtreat TC and Brunophen by Scots Pine Blocks, 6×2×5ins.

Preservative	Method of Application	Amount of Preservative Absorbed (lbs)	Area of Penetration (sq. ins.)	Total Absorption of Preservative (lbs/cu. ft.)	Concn. of Preservative in Penetrated area (lbs./cu. ft.)
Brunophen No. 2	10 minute dip	0.057	3.1	1.6	6.2
Brunophen No. 2	2× brush coats	0.055	3.2	1.6	6.0
Brunophen R60	2× brush coats	0.073	4.6	2.1	5.5
Woodtreat TC	One application as ribbons	0.071	5.6	2.1	4.5

treated using 25 lbs. of emulsion. The volume of wood treated was just over 8 cubic feet giving an absorption of 3 lbs. per cubic foot. The old, dry joists absorbed the Woodtreat rapidly and it had all disappeared in 48 hours.

Woodtreat has remarkable spreading and penetrating properties and, as the joists were treated right down to the level of the plaster board ceiling pinned to their undersides, it is not surprising that this was stained. Whether treatment with bands stopping some inches from the ceiling will prevent this remains to be seen but of course staining in such cases is also a problem with organic solvent type preservatives.

The five new joists used for replacement and reinforcing were of rough sawn redwood, 9 ins. × 2 ins. and obviously has a rather high moisture content although this was not actually determined. The amount of sapwood varied from joist to joist but was of the order of 15—20% Two joists were treated with Woodtreat using a wooden paddle and two others using a two knot distemper brush. Application was easier with the distemper brush but gave a thinner coat. The fifth joist was given two flooding brush coats of organic solvent type preservative. The amounts of preservatives applied and of pentachlorophenol retentions achieved are given in Table II.

It will be seen from the table that a single coat of Woodtreat only 1/16-1/8 ins. thick gave a retention of pentachlorophenol three times greater than that obtained from two brush coats of an organic solvent type preservative applied to a rough sawn surface which holds the liquid and shows brush application to its best advantage.

The trial confirmed in practice the results of laboratory work and emphasised that for ease, speed and accuracy of application, equipment capable of applying Woodtreat as bands or ribbons was essential.

Suitable equipment was subsequently developed and a practical trial was carried out using the "Presser-Pak" to treat rafters in a roof space. The equipment was given to an experienced pest control operator who applied Woodtreat to several dozen joists after a few minutes instructions. The operator seemed to like the product and method of application—an important point with a technique of such interest to curative treatment companies. Figures VIII and IX illustrate the difference between application as an overall coating and as ribbons to timbers *in situ*.

In this trial ribbons $\frac{1}{2}$ ins. wide by $\frac{1}{4}$ ins. thick were applied to both sides of the rafters at six inch intervals. During the trial the total length of rafter treated from one filling ($\frac{1}{2}$ gallon) of the "Presser-Pak" was determined and found to be 48 ft. giving an application rate of $1\frac{1}{2}$ lbs. per cubic foot of timber. The Woodtreat was absorbed within a week of application. Larger ribbons placed at wider intervals should enable both the rate of application and the speed of working to be increased.

Equipment for Applying Woodtreat

The "Presser-Pak" mentioned above is hand operated knapsack-type of apparatus. It has a webbing sling for carrying on the shoulder or it can be laid safely on the ground on special rests to prevent rolling. It consists of an outer container which is charged with air by 20/30 strokes of a built-in hand pump. Inside the outer cylinder is an inner cylinder containing the Woodtreat. The air in the outer container presses on a piston in the inner cylinder forcing the emulsion through the delivery tube attached to the top of the inner cylinder and from thence to the lance. The lance has a pistol grip and trigger operated cut-off valve. It ends with a rectangular orifice giving a ribbon roughly $\frac{1}{2}$ ins. wide. The thickness of the ribbon can be adjusted by the speed with which the operator allows the emulsion to emerge. A variety of nozzles will probably prove useful in practice and there is still scope for experiment on their design.

TABLE II

Treatment of New Joists with Woodtreat TC* and Brunophen No. 2 in a Practical Trial**

Joist Number	Preservative Used	Av. thickness of coating (inches)	Absorption of preservative (lbs/cu. ft).	Retention of pentachlorophenol*** (lbs/cu. ft.)
1.	Woodtreat TC	1/8 – 1/16.	8.3	0.42
2.	„ „	1/16.	5.8	0.29
3.	„ „	1/16 – 1/32	4.0	0.20
4.	„ „	less than 1/32.	2.0	0.10
5.	Brunophen No. 2	2 brush coats.	2.7	0.14

* *Woodtreat TC contains* 8.7% *wt/wt pentachlorophenol.*

** *Brunophen No.* 2 *contains* 5.0% *wt/wt pentachlorophenol.*

*** *Corrected to a basis of* 5.0% *wt/wt pentachlorophenol for Woodtreat.*

The main disadvantage of the "Presser-Pak" is its small capacity but this is overcome by using an"easy-fill"device which pumps Woodtreat directly from the drum in which it is delivered into the inner cylinder against the air pressure in the apparatus.

For large scale work preliminary experiments have been carried out with a compressed air pump which is a simple adaptation of equipment used for dispensing heavy oils and greases. It draws the Woodtreat direct from a 40/45 gallon barrel and will deliver it through a hundred or more feet of hose. It needs a supply of air at 25 lbs./cu. ft. from 9 cu. ft. compressor to operate it.

Discussion

Woodtreat provides a means whereby timber can be deeply and evenly impregnated with large amounts of preservative applied as a single controlled application to the surface of the timber. It is, therefore, of obvious importance for eradication of rot, woodworm and termites. As one application gives deeper and more even penetration than several brush or spray coats of organic solvent type preservative, its use will save repeated visits to carry out spaced spraying and should reduce time and costs especially when work is being carried out in areas not easily accessible. The use of Woodtreat has other advantages such as absence of spray mist with a consequent reduction of danger of fire and of toxic hazards to operators. Operators will find it more pleasant than sprays to work with, especially in confined spaces, and thoroughness of application can be readily checked and supervised.

Fig. VIII Application of Woodtreat as an overall coating to timber in situ. *A wooden paddle is being used as an applicator*

Fig. IX Woodtreat applied to rafters as ribbons using the "Presser-Pak"

It is not suggested or expected that Woodtreat will replace organic solvent type preservatives for eradication work, but it will provide a most useful additional weapon against the insect and fungus enemies of timber, especially when treating large size timbers and when long-term protection from reinfestation is required.

The standard product used by curative treatment organisations in the U.S.A. contains 8.7% wt/wt pentachlorophenol, but it is proposed to meet British and Commonwealth requirements by reducing the pentachlorophenol to 5% and incorporating an insecticide such as dieldrin. Although the formulation of Woodtreat is extremely critical it might be possible to incorporate preservative chemicals other than pentachlorophenol.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the valuable help and guidance given throughout this work by Dr. Ira Hatfield of Wood Treating Chemicals Co., of Missouri and to thank Mr. C. M. Bassett and Mr. W. C. Shear for their co-operation with work in this country and, in particular, for carrying out the redwood block penetration tests.

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Note: Woodtreat and Brunophen are registered trade names.

Photos by D. Boocock.

AN ENQUIRY INTO THE CONTROL OF PESTS OF RACING PIGEONS

By
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R.E.

Introduction

MANY interesting problems arise from the unnatural conditions imposed on racing pigeons in their housing, feeding, breeding and training for racing. There is a surprisingly large number of Fanciers taking part in races each season and it appears reasonable to assume that well over 90% of them experience trouble in some degree through infestation, although many of them may not necessarily be aware of it.

The initial difficulty in this subject is the absence of any complete and authentic literature regarding the pests concerned in the United Kingdom. Those pests which may be considered include the following:-

Argas reflexus; Cnemidocoptes gallinae; Trombicula autumnalis; Dermanyssus gallinae; Liponyssus sylvarium and/or *L. bursa;*

Cuclotogaster (*Lipeurus*) *baculus* (*caponis?*); *Ceratophilus gallinae; Columbicola columbae; Menopon gallinae; Goniocotes gallinae.*

A survey of pests of pigeons throughout the U.K. would consequently be of great value.

Origins of Infestation in Racing Pigeons

Enquiry reveals perhaps that in no other domesticated animal do so many possibilities for infestation by body pests arise.

In commencement, a high proportion of lofts must start any one year carrying a residual infestation of one or other of the more common pests. Enquiries of fanciers in three localities of England and Wales revealed that on average in only 5% of lofts was an attempt made to carry out annual disinfestation, although some 75% of fanciers carried out some form of chemical treatment on their birds "when infestation was obvious". In a few cases it was stated that visible pests were removed by hand. It may be concluded in general, therefore, that the attitude of the racing fancier towards infestation is at present similar to that of the poultry keeper some fifteen years ago; in particular of course there are the few exceptions of fanciers who appreciate the damage caused by body pests and do everything in their power to control them.

Residual infestation in lofts finds opportunity for natural increase with the onset of breeding, when, from mid-February onwards, nests and nesting box materials provide reasonably suitable conditions for the purpose, the newly hatched young and squeakers providing excellent feeding material for most of the pests concerned.

With the advent of warmer weather a more widespread and rapid increase in population occurs, the time of peak population of pests depending on the particular season's weather.

During the racing season, numerous opportunities occur for cross-infestation to take place. Cross-infestation and in the case of clean stock, reinfestation, may occur from basket to basket at rail despatch points, in rail vans, at race assembly points and from re-use of infested baskets.

Other opportunities for cross-infestation or reinfestation may lie in:

(a) improper disposal of litter and/or droppings from infested baskets and lofts; certain stages in the life cycle of some pests develop in these materials and unless they are destroyed by burning or by treatment with an appropriate chemical they provide a reservoir of infestation;

(b) positioning of a loft near to poultry frequently presents the risk of spread of infestation from either to the other, resulting in equal trouble;

(c) incomplete disinfestation of loft and associated land; this results usually from chemical treatment not being carried out on undersurfaces of raised lofts or on the land beneath the loft and in any aviary which may form part of the loft;

(d) visitations of stray pigeons and other birds to a loft or its fabric; a practice which, only from short experience of the author, is commoner than was supposed;

(e) rodent infestations of the loft or associated ground or buildings; rodents can become secondary hosts to certain pests of pigeons in which circumstances they can cross or reinfest a loft;

(f) situation of a loft near to suitable vegetation and in a district where harvest mites recur annually, allied to a tendency for pigeons of that loft to be disposed towards ground feeding;

(g) purchase or use of infested second-hand timber or loft fabric or of stock from an infested loft.

There is no known data on the extent to which the foregoing possibilities do in fact occur in practice. In the light of the Fancy's general attitude towards insect and mite pests, however, which currently is not impressive from the point of view of action being taken, it must be accepted that all the possibilities are real ones.

The Significance of Infestation in Racing Pigeons

It is logical, by direct comparison with the importance of closely related pests on poultry, to assume that infestation in racing pigeons must have an adverse effect on vitality in general and on specific seasonal functions such as egg-laying, rearing of young, moulting and racing. At the very least, some irritation will be apparent or experienced, causing lack of proper rest, with resultant reduction in racing 'form'.

Excepting the really large species of adult lice, very close inspection and examination of a pigeon is needed to determine the presence of any but moderately heavy or heavy infestations, and particularly this applies to mites. It is clear that a great number of fanciers attach little or no importance to mites and frequently are not even aware of their presence. This state of affairs is largely responsible for the present definite possibility of cross-infestation occurring between baskets during transit (to and from races).

The Fancy is made up of individuals from all walks of life and to draw the importance of pests to the attention of all concerned is not straightforward. Certainly very little if any good would be achieved by publishing detailed pictures and life histories of the pests concerned with the object of aiding indentification. It, therefore, appears that whilst research work on the pests of pigeons and on the control of those pests is highly desirable, quite a different method of instructing the Fancy will be necessary, from the usual media of periodicals, newspapers and magazines.

Physical Methods of Control of Pests of Pigeons

"Two known methods" of controlling insect and mite pests are:-

(a) removal of visible pests by hand, and

(b) heat treatment of loft fabric surfaces, using a blow torch or similar for the purpose.

The first of these is only of very limited value at any time and cannot strictly be termed control. The second is likely to cause more deterioration of loft fabric than its short term beneficial effect against certain pests is worth.

Chemicals Used Against Pests of Pigeons

Materials used as insecticides and acaricides currently and in the past may be grouped as follows:-

(a) inorganic chemicals;

(b) organic or synthetic chemicals;

(c) botanical preparations or extracts.

(a) *Inorganic chemicals*

In this group, appreciable usage has only been made of sodium fluoride and/or sodium silicofluoride. Used in the main as a finely divided dusting powder on the birds themselves, it was at one time the only material recommended for control of lice in the U.S.A.[1] Some small use of it has been and still is made in water solution as a dip in U.K. Among the disadvantages in its use are the facts that it is a scheduled poison in this country and, therefore, carries inherent risks in use and storage; it is virtually ineffective against Acarine pests; in any event it only provides a treatment for the birds themselves, its use not being translatable to the loft. Levi[2] details usage of this chemical.

Limited use has been made of sodium or potassium sulphide as a half per cent. aqueous solution for control of feather mites. Davidson[3] and Wood[4] advise preparations of sulphur which probably result in a similar product when used. Osman[5] details usage in this country, but it does not appear to have been used sufficiently frequently and on a large enough scale to have proved consistent control of feather mites. Its effectiveness against other Acarine pests of Pigeons is still open to question.

Very limited use has been made again of nicotine sulphate in this country although its use in the U.S.A. until recent years has been extensive; another scheduled poison in U.K., its use was directed chiefly against red mite (*Dermanyssus*).

(b) *Organic or synthetic chemicals*

DDT, benzene hexachloride, lindane, dieldrin and aldrin are known to have been used against pests of pigeons in this country, on the continent and in U.S.A., and more recently, work on malathion has been reported on in U.S.A.[6] and U.K.[7]

It is unfortunate that practically no literature on the use of these materials has been published in this country. dieldrin and aldrin do not appear to have had any kind of reasonable trial, accounted for perhaps by unfortunate happenings in the field[8]. Adverse effects of the use of benzene hexachloride on pigeons have been reported to me[9] but these do not apparently apply to the purified gamma isomer which has found extensive use on the continent.

In any event, if it is desired to find a single material which will provide maximum control of both Insect and Acarine pests, the only one of the synthetics listed above which can be assessed is malathion, since both DDT and benzene hexachloride are relatively useless against mites.

(c) *Botanical preparations*

Preparations of pyrethrum, derris and quassia have for many years been used either as dips, dusting powders or sprays against pests of pigeons. Pyerethrum sprays have been used in the poultry industry against all pests of poultry with good success for the last twelve years.

The chief disadvantage of these materials from the point of view of disinfesting lofts and pigeons is the absence of any but the shortest term residual effect. For treatment of individual birds returning to a clean loft after being subjected to the possibility of re-infestation however, pyrethrum preparations are certainly the ideal materials to apply in spot treatments.

Methods of Application of Chemicals to Lofts and Pigeons

Chemicals may be applied in the following ways to control infestation:-

(1) as finely divided dusting powders;
(2) as smokes or vapours;
(3) as gases (i.e fumigants);
(4) as 'wet sprays' intended to leave a film of residual chemical on treated surfaces;
(5) as 'space sprays' intended to fill an enclosed space with a mist or fog of "aerosol" particles;
(6) as baits, with an added attractant;
(7) as aqueous dips.

Of these several ways, the use of gases, smokes and vapours are ruled out of consideration for treatment of lofts because of the general unsealable nature of these structures. Baits are of no value in view of the feeding habits of the pests concerned, whilst dusting powders are only suitable for use on the birds themselves if cleanliness is of a reasonably good standard in the loft.

Space or "aerosol" sprays have found very considerable use in the poultry industry against pests very similar to and sometimes the same as those of pigeons. Unfortunately only a very small percentage of lofts in U.K. are so constructed as to be at once suitable for or simply adapted to this method of routine control. The expense of the necessary precision built and powered equipment also discounts the possibility of the method becoming widely used in the Fancy, although for those who can afford it there is probably no better and easier way of completely controlling all pests of pigeons as well as (by use of suitable bactericides) spread of many diseases. Suitable equipment for this purpose is Microsol manufactured by the Silver Creek Precision Corporation.

Application of chemical as a wet spray appears to be the most suitable for general practice in loft treatment, always providing that application is simple and can be repeated at intervals so as to replace the residual chemical which normally is quickly lost by cleaning, movement of birds, vaporisation in hot weather, etc.

For treatment of actual birds a choice appears to lie between the application of chemical as a fine spray or more simply still by dipping the bird in the chemical.

Equipment for Application of Chemicals

Choice of equipment by the Fancy will ultimately depend on simplicity of operation and cost. In a high proportion of sites where lofts are established there is no water or electrical supply to the loft, nor likely to be; the use of these two forms of power for spraying equipment is, therefore, largely ruled out.

Thorough residual spraying treatment of a loft requires the use of at least a gallon of made-up insecticide and there is no greatly better way of applying this quantity quickly than by use of a stirrup pump or garden syringe or even a large brush. Financial outlay in this direction is consequently not essential although it could be an advantage to have available a pneumatic type of sprayer giving a controlled fine or coarse spray.

For application of chemical to birds themselves however, and unless the dipping method is used, a somewhat more refined applicator is needed. If expense is no object, individual birds can be sprayed with hand-size aerosol dispensers containing suitable pesticidal components. Alternatively a small variety of hand-trigger-pressurised sprayers is currently marketed and these give equally good results from the point of view of spray distribution.

The disadvantages of both aerosol dispenser and small handsprayer is that only one of the fancier's hands remains free to manipulate the bird during treatment. Two persons are, therefore, necessary to carry out this treatment if thorough and even distribution of pesticide is to be achieved, however skilled the fancier may be.

It is rather obvious, therefore, that if spraying of individual pigeons is to become a routine feature of pest control by fanciers, some adaptation of existing

equipment is essential and which leaves both hands free to do the work of spraying, or of manipulation of the bird.

Practical Requirements for Control of Infestation in Lofts and on Birds

Summarised, the chief requirements which have been assessed from conversation with numerous fanciers and from general principles of pest control are as follows:-

1. Some means must be found to educate the majority of fanciers to the extent that infestation control becomes an important feature in pigeon husbandry.
2. A method of control of infestation, or alternative methods of control, such as have been established in the Poultry Industry, must be developed for the Fancy.
3. In view of the fact that reinfestation of lofts is always possible as a result of birds or baskets becoming infested through the pursuit of Racing it is reasonable to propose that two methods of control are needed, the one based on treatment of loft with residual-effect material, repeating such treatment in accordance with the known effective "life" of the material used, and the other concerned with a necessarily repetitive treatment of actual birds.
4. It is essential that the two proposed methods should be applicable to litter, baskets, aviaries, nesting material and any other fabric or equipment connected with the maintenance of a loft, not forgetting used litter and manure.
5. Methods and materials used must be such as will have no detrimental effect on eggs, newly hatched young, squeakers and of course birds training for racing. It is in this last respect that difficulties are likely to arise in practice, possibly based on conservatism or prejudice in some cases. There is for example an argument held by many fanciers to the effect that racing birds should be trained to a routine which does not include a possibly upsetting break in the form of a dip or spray treatment. If birds training for racing were actually infested it can equally well be argued that the effect of such infestation on the birds is likely to be more deleterious than would be the provision of treatment against those pests. However, in order to preclude such debatable problems, it may be possible to provide a treatment for birds intended for racing which can be applied several weeks before actual racing commences and which can be followed up by spot treatment of birds immediately returned from racing through use of perhaps a pyrethrum-based insecticide.
6. The Fancy appears to be considerably divided over the suitability of dipping and spraying in treatment of actual birds; no division ratio has been ascertained but amongst the well known fanciers of U.K. it may be about equal. The only pertinent references in the literature is given by Lapage [10]. It may well be that the routine process of dipping may condition birds to it. In regard to spraying birds, there is always the risk that carrier or solvent material or the pesticide itself may in one or repeated applications cause distress or a cumulative deleterious effect.

Suitability Trials Carried Out on Racing Pigeons 1959—60

It will be clearly understood that, since trials commenced in December 1959, no attempt was made to assess actual pesticidal results. Now that pigeon pests are rapidly on the increase in 1960 field trials have been arranged to determine efficacy of the materials here reported as apparently having no obvious ill effect on pigeons themselves.

Two pesticidal preparations were chosen for the trials on the basis that they were known to be moderately effective even when badly used against pests of poultry. They were pyrethenoids and malathion supplied respectively by Ref. II and Ref.12.

The pyrethrenoids concentrate, containing synergist, was stated to have a biological equivalent of 20% total pyretherins. It was used exclusively diluted with ordinary garage paraffin in the ratio of 1 to 19 by volume.

The malathion concentrate referred to hereafter as MX contained 20% of Agricultural Grade Malathion and 20% of an ester of benzyl alcohol which is known to have appreciable Acaricidal properties as well as a disinfectant value.

Details of the solvents and other essential ingredients of the two materials may be obtained from the manufacturers. Neither concentrate is available on the normal retail market.

Trial No. 1

A batch of seven birds of average age 7 months (5m; 2 females) were used for application of MX insecticide by spraying. The batch was increased by one female on March 18th.

Details of Application

Treatment Ref.	Date	Site	Material Used	Qty. used per Bird
A	1/12/59	Laboratory	1% MX	1¼ fl.oz.
B	14/12/59	do.	4% MX	do.
C	28/12/59	do.	4% MX	do.
D	18/1/60	Aviary A	4% MX	do.
E	1/2/60	do.	4% MX	do.
F	15/2/60	do.	4% MX	do.
G	11/4/60	do.	4% MX	do.
H	19/5/60	do.	4% MX	do.
L	6/6/60	do.	4% MX	do.

Actual spraying was carried out by two persons, one operating the sprayer and the other manipulating the bird to ensure even and thorough application.

The sprayer used, of 1½ pints capacity, was hand pressurised and gave a medium-coarse spray circle of 9 inches diameter at a target distance of 11 inches.

Laboratory conditions consisted of totally closed rooms with standard door to window ventilation. Birds were separately caged in show cages modified for easy cleaning purposes. Food was provided daily, consisting of a Pigeon Winter Feed sold locally. Water was also provided at the same time as food, i.e. 8 a.m. and 3 p.m. until Summer Time commenced when the afternoon feed was changed to 6 p.m. Food and water utensils were removed and sterilised after each spraying treatment to avoid any possible contamination. Spraying was carried out at 11 a.m. on all occasions. Aviary A was built of all new materials and used for the first time with this batch of birds. Before use and before sections were assembled it was liberally painted inside and out with 4% MX allowing the material to run into cracks between the T & G boards of which it was entirely clad. The loft portion was 6 ft. by 4 ft. containing a block of six nest boxes and communicating with an aviary 6 ft. by 6 ft. by 6 ft. high. Birds were allowed access to the aviary during daylight hours only.

Trial No. 2

The birds used in the first Trial were despatched to Enfield, Middlesex from Wrexham, Denbighshire on December 29th, 1959, in a basket and with litter both of which had been treated with the same insecticide as was used on the birds.

On arrival after this rail journey of approximately 200 miles, the birds remained confined to the same basket for a total of 96 hours (including journey time) being fed and watered in accordance with Racing Regulations. The period of 96 hours is normally the maximum encountered under racing conditions.

The litter used was a medium grade sawdust and not the wood shavings which are normally employed for this purpose. The reason for using sawdust was to be sure that the birds would contact the impregnated material as much as possible and to a greater extent than if shavings had been employed.

Details of Application

Basket and litter were sprayed with 4% MX using the same sprayer as in Trial 1. The litter was spread thinly on a concrete floor and received 4 fl. ozs. insecticide per pound of dry weight. The basket was thoroughly sprayed so as to wet all inside and outside surfaces and cracks and crevices, 6 fl. ozs. being required for the purpose. Treatment was carried out on Dec. 27th, 1959, both litter and basket being allowed twenty hours to dry out at a temperature of 60 deg. F. before being moved.

Trial No. 3

A batch of six birds (4 male, 2 female) were used to observe the effect of spraying them with pyrethrins in kerosene, hereafter referred to as insecticide BP.

Spraying was carried out with a 4 fl. oz. capacity hand-trigger-pumped fine sprayer held at a distance of six inches from the target where the spray circle was of five inches diameter.

In March, twelve more birds were added to this batch, which then comprised 6 males and 12 females. At the time the addition was made all eighteen birds were transferred to Aviary B which comprised a loft 6 ft. by 6 ft. and aviary of almost the same size, the overall height being 6 ft. No treatment of this loft and aviary was made at any time and it was first ever used for this Trial.

Details of Application

Treatment Ref.	Date	Site	Material Used	Quantity Used
1. 6 Adults	1/12/59	Laboratory	1% BP	2ml. per bird
2. do.	8/12/59	do.	do.	do.
3. do.	15/12/59	do.	do.	do.
4. do.	22/12/59	do.	do.	do.
5. 18 Adults	11/4/60	Aviary B	do.	do.
6. do.	18/4/60	do.	do.	do.
7. do.	25/4/60	do.	do.	do.
8. do.	2/5/60	do.	do.	do.
9. 3 Young	9/5/60	do.	do.	1ml. on each of three 3-week-old squeakers
10. do.	16/5/60	do.	do.	do. at 4 weeks
11. do.	23/5/60	do.	do.	2ml. on same three birds at 5 weeks

At June 1st, 1960 there were in this Aviary B the original eighteen adults together with six youngsters and ten eggs sitting. Two eggs hatched in March survived less than twenty-four hours; two further eggs failed to hatch and on examination proved to be infertile.

Results of Suitability Trials

All pigeons have survived all pesticidal treatments. Moreover there has been no appreciable effect on reproduction, i.e. egg laying, live hatching, feeding of and development of young. Breeding started quite late in the season, it being purposely held back whilst the aviaries were under construction and became ready for use.

Spraying of pyrethrins in paraffin insecticide apparently caused no distress of any kind, either on adults or young from 3 weeks old.

Spraying treatment with MX insecticide on every occasion caused short term (3 to 5 minutes) irritation of the eyes. No other signs of distress were observed.

Minute examination of the pigeons used in Trials Nos. 1 and 2 was made by a recognised authority on racing pigeons[13] whose report in January 1960 states that all birds were in extremely good condition, if anything better than average for the time of year, and that confinement to a treated basket in contact with treated litter had no apparent ill-effect on them.

Summary

The following conclusions are made:-

(1) The Racing Pigeon Fancy is in need of general education in the distress which must be caused to birds by body pests;

(2) It would be of great assistance for pests of pigeons to be surveyed in United Kingdom and reported in the literature.

(3) Further work on the application of and composition of pesticidal materials to pigeons is required, particularly as regards their effectiveness.

(4) If the spraying of pigeons is to become a general feature in pigeon husbandry, the development of a sprayer which will leave both hands free to manipulate the bird is indicated.

(5) Information concerning the dipping of pigeons is very desirable with a view to replacing the spraying method.

(6) Certain pyrethrins and malathion preparations may prove suitable for recommendation to the Fancy.

(7) Co-operation of the Fancy is required to investigate the claim that any kind of treatment applied to a bird immediately prior to racing may adversely affect racing performance.[14]

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SPRAY NOZZLES

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SOMEBODY, probably a manufacturer of pumps, once claimed that the pump was the heart of a sprayer, implying that a customer should realise that without a respectable pump a sprayer was of little value (and also that he should know where to go to buy one). In a similar fashion, I suggest that we can regard the nozzle as the brain of the machine. The pump supplies the power but depends upon the nozzle for this power to be used most effectively.

Unfortunately for this undoubtedly brilliant thesis, present day pesticides are so effective and such a bargain and pests are so obligingly willing to commit suicide on top of these spray chemicals, that the sprayer does not need a brain for 90% of its work. In practice a rough and ready nozzle of mediocre performance, viewed as a nozzle, is often nearly as good from the point of view of pest and disease control, as a nozzle of precise performance. (This claim is made on the basis that we cannot prove that the opposite of it is true.)

Occasionally however this generalisation is false and sometimes a sprayer needs the correct nozzle for the job in hand. The following description of spray nozzles is written mainly for these tasks. It is certain that the correct nozzle does a slightly better job slightly more economically even in those tasks where a less suitable nozzle is passably effective, but the improvement may be too small to bother about. Whether or not one should take trouble to obtain a proper nozzle performance depends firstly upon the degree of unsuitability of the inferior nozzle and secondly upon the scale of the spraying operation. A contractor working on a large scale has to know what nozzles he needs and to make sure that he gets them for all work. A farmer on the other hand can probably afford to be less particular for his smaller scale work, which may not be such an important matter for the overall profitability of the farm. There are plant protection tasks wherein a farmer also should be particular and examples are described towards the end of this essay.

Sometimes the selection of a special nozzle is easily done but more usually it is a complex task because so many factors have a bearing on the choice as is suggested by the following account of what a nozzle must be and do.

Functions of a Nozzle

Speaking broadly, a nozzle has to do only two things —form a spray of the required fineness and uniformity and then distribute the spray drops in space and in such a manner that they become effective most economically.

Therefore we have the choice firstly of fine, medium or coarse spray where these terms embrace the size range 20 to 1000 microns. The properties of such a wide range of sizes of drops vary widely. For example, impaction onto a leaf varies from 0 to 100%. Settling velocities vary from 0 to 800 ft./minute and range, when projected at 40 miles per hour, from 0 to a few yards. (In each case zero means zero for practical purposes). The point in emphasising the breadth of the performance figures is to emphasise also that this range 20 to 1000 microns is found now in practice. So it is little to be wondered at that different nozzles sometimes give different biological effects.

Secondly, a nozzle may also be chosen to give drops all of one size more or less, or of a wide range of sizes. In certain situations one could make a reasonable apriori case for either uniform spray or sprays containing a wide range of drop sizes. A greater degree of uniformity

FIG. I.

A low pressure coarse spray.

Pressure at 7 p.s.i.

when it is required, might require a different type of nozzle, a different design of the same general type, at change in working pressure or even a change in the physical properties of the spray fluid.

Any nozzle is also required to direct and distribute the spray, which it forms, onto the target to be treated. The distribution of the liquid in the spray zone; the position and dimensions of this zone relative to the targets; the range to which this spray pattern persists, are all functions of the spray nozzle on most spraying machines. Small volume sprayers however, have only a very short range because of the small momentum of the spray stream. Accordingly it is usual to support the spray with a jet of air mainly when treating tree crops but also ground crops to a small extent. Then the distribution of the spray over the target and through the leaf canopy is controlled more by the airstream than by the initial distribution of spray formed by the nozzle.

If a nozzle does this work which is required of it then a numbel of subsidiary selection criteria become significant. There is firstly the ancilliary equipment to be-considered. A nozzle requires some source of fluid or mechanical energy—a pump, a fan or a motor for example, to both form the spray and to p oject it. Often it is not possible or desirable for economic or practical reasons to fit certain items of ancilliary equipment and this limits the choice of nozzle. For example, the powered knapsack sprayers cannot be large volume sprayers and still remain portable. Since small spray volumes have a short range these sprayers must (more or less) be fitted with a fan if they are needed to work with a range longer than about three feet. Since furthermore the presence of a fan prohibits, for practical reasons, the use of a pump, such sprayers cannot use hydraulic nozzles. They must therefore use airblast nozzles or a rotating nozzle even though it might be that by other criteria a hydraulic nozzle would be preferable.

Any nozzle which is suitable in performance and which suits the type of spraying machine to be used, must also meet a number of practical requirements in terms of price, corrosion and wear resistance, throughput and finally in mechanical robustness. Such needs, however, are normally met by nearly all nozzles.

There are clearly a large number of ways in which nozzles can, and have been, made to provide the requiied performance in a practicable form. However, nearly all of them can be considered to be a member of one of only three classes of nozzle. These three main groups are described below since the main selection which has to be made for any spraying task is to decide which of them to use, although the subsequent choice of a representative from the selected group is also important. The ways in which the three types of nozzle achieve their performance is also described qualitatively since an understanding of them is an aid to comparing their merits for different purposes.

Types of Nozzle

The three main classes which cover 99% of plant protection are hydraulic, air blast and rotating nozzles.

Hydraulic nozzles work by means of pressure imparted to the spray liquid. Because of this pressure the liquid

is ejected from the nozzle at high speed and it is torn into drops mainly through the effects of air resistance. Usually such hydraulic nozzles are designed so that the issuing liquid is constrained to form a thin film. One major subdivision of this class forms a conical film by causing the spray liquid to rotate within the nozzle. In the other subdivision of hydraulic nozzles the liquid is made to form a flat film.

Finer spray is formed from a film of liquid than from a cylinder of liquid from a plain nozzle of equal output to the film forming nozzles. Also the configuration of the film controls the distribution of the spray material across the spray swathe.

A rough calculation of the thickness of such a film can easily be made by assuming a spray speed of say 40 miles per hour at a pressure of 30 p.s.i. and a film width of an inch. The thickness of the film is then found to be very small—10 microns—for a small volume nozzle. The spray formed from this is likely to have a most probably drop diameter of perhaps 100 microns. Accordingly quite large areas of sheet roll up into a ball to form the drops. It is because a hydraulic nozzle forms a film that it is very much more efficient, as shown below, at forming a spray than the other types of nozzle.

Airblast nozzles are similar in principle although different in practice. In these the liquid is ejected only slowly at a low pressure and usually through a relatively large hole which cannot block easily. The air is blown past the issuing liquid at high speed and breaks it to pieces. Just as with the hydraulic nozzles, in the more efficient of airblast nozzles the liquid is presented to the air in the form of a moderately thin film. The air stream disrupts this more effectively than it could a solid rod of liquid and so a finer spray results.

The distribution through space of the spray formed by these air blast nozzles is controlled by where the air goes to and by the extent to which the spray is entrained into the various portions of the airstream. A solid cone of spray, a hollow cone or a flat fan of spray can readily be formed by suitable guides for the air.

The third main group of nozzles consists of those which rotate—the spinning discs and the spinning cages. Liquid is fed near to the centre of these and is thrown by the rotation of the nozzle into a tangential path. Spray is formed mainly in one of two ways (by forming liquid ligaments or individual drops) which lead to different drop size ranges. The distribution of spray is in all cases a flat circle and is generally unsuitable for most spraying tasks (other than spraying the inside of a circular tunnel) and so an airstream is usually used to redirect the spray towards a target. One interesting machine however works with this circular disc of spray in a vertical plane. The spray going towards the ground is trapped and fed back to the tank while the remainder is flung out a distance of several feet at the tall crops on either side of and above the sprayer.

How they Work

Hydraulic Nozzles

In swirl nozzles the liquid is caused to rotate by passing through short spiral channels in the swirl plate. The greater this rotational speed compared with the flow parallel to the axis of the nozzle, the wider the divergence of the cone. In practice the wider cone leads to a finer spray, shorter range of projection and naturally a more widespread distribution of the spray liquid. Most flat fan nozzles which are used for plant protection consists of a single orifice which converges sharply in one plane and causes a fan to be formed in the plane at right angles to this convergence. The greater the convergence the wider the fan. These spray sheets break up in a number of ways depending upon their thickness, speed and the degree of turbulence in the liquid film.

Fig. 1 shows a flash photograph of spray breaking up into fairly regular large drops. This break up occurs through the sheet rolling into ligaments and the ligaments breaking up under the influence of surface tension, in the manner described by Lord Rayleigh in the early work on nozzles.

At slightly higher pressures of say, 20 p.s.i. for water, this break up pattern changes into direct break up of the liquid sheet in the case of a thin film and through shearing of drops from the liquid surface in the case of a thick film. In either case, rather suddenly, the spray contains a much larger proportion of fines—the under 100 microns fraction. So not only does the mean drop size decrease but we have a little evidence which shows how the drop size distribution also changes as the pressure rises.

Fig. 2 illustrates the effect that the speed at which the spray emerges from the nozzle, has on the mean drop size formed by the spray. The results are for swirl nozzles—a few of them our own but they are mostly from the data of other investigators. A flat nozzle would give drop sizes about 10% larger.

When choosing a suitable hydraulic nozzle, firstly we need to know the spray output required in terms of acres per hour to be sprayed and gallons per acre to be applied. This output can then be obtained with several small nozzles or fewer larger nozzles either at high or low pressure. Fewer large nozzles are often more convenient, providing a coarser spray or a higher pressure are acceptable.

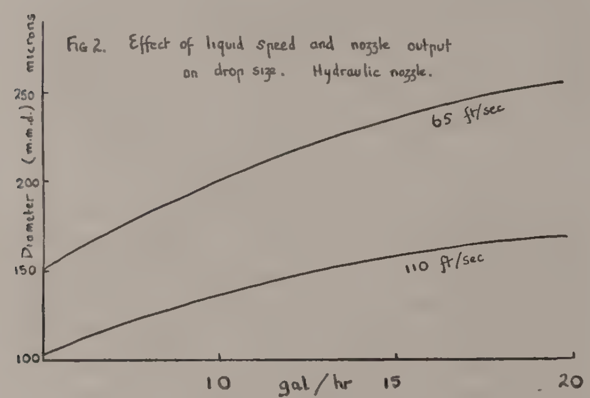
Spray angle and spray distribution within this angle are variable nearly independently of drop sizes and spray output. Spray range on the other hand is dependent upon spray angle, liquid output and drop size. Fig. 3 shows how far drops of spray can be projected. Only a short range can be obtained although it is usually sufficient for ground crops. However, when a whole mass of such drops are projected together they drag with them a stream of air which carries them far further in the manner of a fire fighting nozzle. More usually,

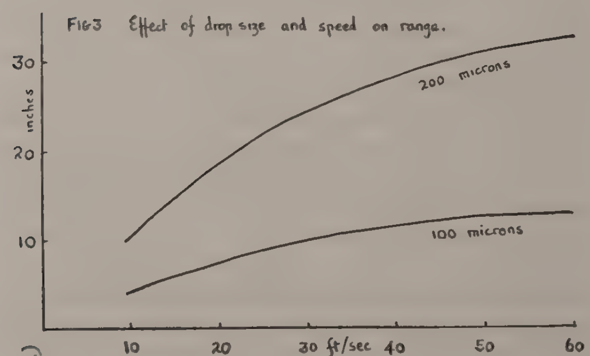
for plant protection, the limited range of the spray drops is overcome by supplying a separate air stream to blow them to a remote crop.

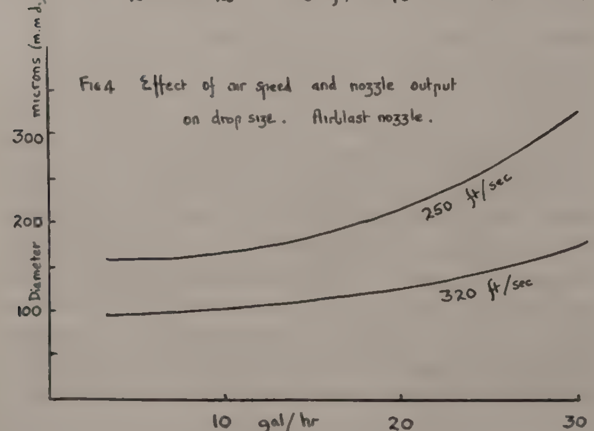
The characteristics of these nozzles are mainly as follows. Firstly at very modest liquid speeds a passably fine spray is formed e.g. 100 microns by small capacity nozzles of 10 gallons an hour when spraying watery liquids. The drop size of larger nozzles is somewhat greater but nevertheless a wide range of outputs can be obtained without suffering a marked increase in drop size. A change in output has to be achieved by altering the nozzle size or the spray pressure or both.

But for all their simple efficiency the hydraulic nozzles have limitations. One of their biggest drawbacks is that they block too readily. Swirl nozzles block less easily than most flat nozzles. (Also because of the inclined streams of spray from a swirl nozzle, penetration into and around the foliage canopy is more complete with swirl nozzles but it is still not good compared with a very fine, 50 microns spray, carried on turbulent airstream). A second drawback is that a really fine spray, fine enough not to settle quickly and to have a low impaction efficiency cannot, apparently, be obtained with hydraulic nozzles at the modest pressures which are convenient—say 100 p.s.i.—off a roller vane or diaphragm pump.

Although these are the main nozzles for general purpose work, the other types of nozzles are sometimes preferable for some special tasks.







Airblast Nozzles

Airblast nozzles used for plant protection usually work off the low pressure air (up to 200 miles per hour) obtainable with a single stage fan which is sometimes necessary in any case to project the spray to remote targets. Since the air is available we might as well use it to form the spray.

Fig. 4 shows the drop size performance of an N.I.A.E. airblast nozzle which is thought to be somewhat better at forming small drops than most commercial nozzles, particularly at higher spray throughputs. The nozzles are also almost unblockable since hole sizes range upwards from an eighth of an inch. But it can be seen that when forming a fine spray of 100 microns they are a little expensive in requiring rather higher air speeds than would perhaps be used to obtain the most economical use of fan horsepower to achieve a long range. The spray distribution obtained is dependent upon the nozzle to only a small extent and is controlled mainly by the airstream.

Relative to hydraulic nozzles the airblast nozzles have these advantages and disadvantages. They do not block and they work at very low and therefore inexpensive liquid pressures. They do however require an expensive supply of air pressure but if this is necessary to project the spray, the cost is not all attributable to the airblast nozzle. Nevertheless they are on the costly side. They can be made to form a finer spray than hydraulic nozzles but only by using rather high relative speeds. It is however cheap to move air quickly but expensive to move liquid faster than about one hundred miles an hour

The distribution of spray drop sizes about the mean is similar for both types of nozzle at similar throughputs. However, at very low throughputs (0.1 ml./min.) suitable designs of airblast nozzle e.g. using a hypodermic needle, can be made to give narrow drop spectra. The hypodermic needle nozzle is a useful one for laboratory scale experimental work on the effects of varying drop size.

Rotating Nozzles

If a narrow range of drop sizes is needed for field scale work then one of the rotating nozzles is needed. These

work in this fashion. Liquid is poured onto a rotating surface and flung from its edge. At usual throughputs cylindrical streams of liquid pour out and break up fairly uniformly along their length. So in principle these nozzles are similar to hydraulic nozzles working at low pressure which also form thin ligaments but ligaments which are orientated perpendicularly to the direction of their movement. In practice the ligament formation of a disc is more regular than that of a nozzle, the drop size range is far narrower and also the ligaments lie parallel to their direction of motion.

From suitable designs of rotating nozzle a wide range of liquid throughputs (up to 10 gallons a minute at present) and almost any desired drop size can be obtained. A narrower drop size range is obtainable from these nozzles than from other nozzles of similar capacity.

For experimental work, these spinning discs are used rather differently. At flow rates of up to a few ml. per minute, drops of two sizes only are formed—one size is about a third of the other. It is easy to separate the two and so obtain a supply of drops of only one size at rates of flow which permit experiments to be done at an acceptable speed on plots of several square yards. This can be done with other nozzles but nothing like so easily and conveniently with them as with a spinning disc. Fig. 5 shows a laboratory model which is cheap and convenient for work in the range 40 to 400 microns. At any mean drop size the range of drop sizes is about 20% of the mean.

For commercial work with mistblowers, the rotating nozzles combine some of the advantages of both the other types of nozzle (at some cost). They work at low pressure and are not easily blocked and they can work with a relatively slow and inexpensive airstream just as a hydraulic nozzle can. For these advantages one must pay in terms of having to use a mechanical, rotating unit in circumstances which are far from favourable. There are two further advantages to the rotating nozzles. Firstly, the drop size that they deliver can be varied at will and quite easily. This is certainly an advantage for experimental work but little evidence is available to show that it is of widespread commercial advantage. This might result from a lack of evidence rather than the non-existence of any advantage. Secondly, the drop spectrum is narrow relative to the other nozzles and this may also have some merit. Clearly wherever a particular drop size can be shown to be the best, then there is good reason to exclude other drop sizes, but once more evidence is not yet available. Since however different sized drops behave differently—settle, impact, drift differently and give different spray cover—some drop sizes must be better than others at least for some of the spraying tasks. Data showing that one drop size is more biologically effective or more suitable in other ways, is however extremely rare. Two fairly clear cut examples are described below from our own work.

Fungicide Protection

When a static fungicide like copper oxychloride is applied to plants, protection from disease occurs only where there are copper ions available to the spores. Accordingly under some meteorological conditions, protection is obtained only wherever the spray (or dust) is deposited on the leaf. So under these conditions a very good spray cover is needed on those leaves of the plants which are susceptible to infection i.e. exposed to it and at a vulnerable development stage.

Probably the best way of obtaining a complete cover of a wettable powder is to apply a very fine spray on an airstream. The small, say 30 micron, drops swirl round the plant like a mist and have a chance of penetrating deeply into the canopy and reaching obscured targets and also, of course, the smaller drops give a more complete cover than larger drops.

Such fine sprays, particularly with wettable powders, are not obtainable conveninetly, if at all, with hydraulic nozzles. Rotating nozzles would do the work but only at high speed and they are not suited on mechanical and

Fig. 5. Lab. spinning disc sprayer

Fig. 6.

A N.I.A.E. cotton sprayer on trial over potatoes

cost grounds to row crop placement spraying. Only a high pressure (5 p.s.i.) airblast nozzle fits the bill. The high efficiency film forming airblast nozzles which are practicable are not suitable since they require too high an air output for this short range work. I should put my money in this example on the simple paint gun nozzle formed from a pair of concentric tubes. This is, like most of the airblast nozzles, nearly unblockable and has a suitably short range.

There are practical snags which might turn out to be important. One is that it is not possible to buy, at the right price, a single stage five pounds per square inch impellor which would fit conveniently onto a tractor. We have tried to use positive displacement blowers and have not found them suitable for agricultural circumstances. However a water piston compressor might be a more practicable proposition.

Another disadvantage is that the nozzles would have to be fed at a very low pressure of say 1 p.s.i. on the liquid feed and this is difficult on a long boom as we have found when trying the same spraying system on cotton sprayers. An example of one of our sprayers working along these lines is shown in Fig. 6. Nevertheless these are practical details made to be overcome and I think the choice of nozzle would be found to be correct.

Drift Prevention

Drift occurs through wind blowing small drops away and if the spray is poisonous this drift might cause harm downwind. The only widespread concern for this drift arises with the use of conventional boom sprayers fitted with hydraulic nozzles and so it is only these that we have to consider.

It is quite easy to show that in a light wind only those drops smaller than 100 microns become drift and travel any distance beyond the headland. So we need a hydraulic nozzle which gives no drops smaller than a hundred microns. This is best done by using a flat fan nozzle, by adding a small proportion of a gelling agent to the spray liquid and by working at the lowest pressure (e.g. 5 to 10 p.s.i.) which provides an acceptable spray distribution (see Fig. 1).

There are quite good swirl nozzles to do this but I prefer a flat since it usually gives about half as much drift. There is a clear cut conclusion here that, as far as I know, only one design of flat fan nozzle has the performance that we require to cut spray drift to very low values. On the other hand several designs of nozzle are able to cut drift to levels which are probably unimportant in most situations.

We are trying to obtain more evidence in other examples to justify a preference for a particular type and design of nozzle. That is we are looking for data to show what sort of nozzle performance is in fact best, in the most general sense, for the task in hand and in the circumstances in which the nozzle is to be used.

Note—Photographs reproduced by kind permission of the N.I.A.E.

Diquat

Imperial Chemical Industries Limited recently announced that diquat, the total herbicide, will be marketed in the U.K. as a potato haulm destroyer and will be available for the 1960 haulm spraying season. Diquat to be sold under the trade name "Reglone", is a quaternary ammonium compound with the chemical name, 1, 1-ethylene-2, 2-dipyridilium dibromide. Its herbicidal properties were first discovered in 1955 at the Jealott's Hill Research Station and in 1958 its use for potato haulm destruction was forecast in a paper read to the 4th British Weed Control Conference.

From the outset diquat appeared to be a winner as far as biological efficiency was concerned but naturally other factors such as the toxic hazards to man and wild life, production costs, etc., had to be determined. For this reason it was first estimated that diquat would be available for the 1961 season. Even this date seemed a little optimistic for tremendous production difficulties faced ICI and at times it seemed as if if would be impossible to manufacture diquat in sufficient quantity at economical cost. In the writer's opinion three factors influenced the Company's determination to see the project through. First the undoubted efficiency of diquat as a haulm dessicator, secondly there are indications that diquat may prove to be useful in other fields of weed control. Last but not least has been the tremendous outcry in the past year against the use of alkali arsenates for potato haulm destruction on the grounds that they are extremely toxic to man and other forms of wild life, there is also the risk of spray drift damage to neighbouring crops.

Biological effects

Diquat is a rapid contact weed killer of practically any vegetation, leaf kill following 3—4 days after application, whilst stem kill takes from 10—14 days. It is as effective as, if not superior to the previously used arsenicals a fact which can best be seen in tables I and II.

Application: The recommended rate of application is 4 pints of Reglone in 20 gallons of water per acre. It can be applied with any standard low volume spraying machine as it is not corrosive. The cost of sufficient "Reglone" to spray an acre will be 55/-.

Safety

In view of the suspect safety of previous haulm killers, Plant Protection have taken special pains to stress the safety of diquat.

Toxic hazards to operators: These are negligible and the Ministry of Agriculture have agreed that the only precautions necessary in handling the product are those consistent with good hygiene. Protective clothing is unnecessary.

TABLE I

Percentage haulm destruction average of trials 1957—59

Days after spraying	'Reglone' (4 *pints in* 20 *gal. water per acre*)	'Hawmac' (1 *gal. in* 20 *gal. water per acre*)
4	54	41
10	85	76
18	97	89

TABLE II

Percentage weed control 14 days after spraying potatoes

Weed species	'Reglone' (4 *pints in* 20 *gal. water per acre*	'Hawmac' (1 *gal. in* 20 *gal. water per acre*
1. Chickweed (*Stellaria media*)	98	98
2. Black bind-weed (*Polygonum convolvulus*)	99	99
3. Annual nettle (*Urtica urens*)	90	90
4. Redshank (*Polygonum persicaria*)	100	100
5. Annual sow thistle (*Sonchus oleraceus*)	100	100
6. Cleavers (*Galium aparine*)	87	83
7. Fat hen (*Chenopodium album*)	100	99
8. Couch grass (aerial growth) (*Agropyron repens*)	52	40

Residues: It has been established that animals receiving as much as 500 p.p.m. of "Reglone" in their total diet over a period of 2 years, have remained healthy, have grown normally and have reproduced normally. This figure of 500 p.p.m. is approximately equivalent to the consumption of some half pound of chemical in a year by an average man. Now the amount of diquat present in tubers, which have had their haulms killed by it, is around 0.05 pp million and one would have to eat something like 12,000 tons of potatoes before ingesting half a lb. of the chemical. It can be reasonably assumed, therefore that there will be no toxic hazards associated with residues.

Livestock: One of the greatest dangers where arsenicals were concerned was the fact that cattle occasionally broke into sprayed fields and ate the treated haulm with consequent disastrous effects. With diquat, however, cattle can eat the treated haulm without being poisoned.

Wild life hazards: Diquat is non-toxic to insects or fish. Game and other birds suffer no ill effects even when directly sprayed at many times the normal rate of application.

Spray drift— phytotoxic effects: Although at suitable doses diquat will rapidly kill any vegatation with which it comes into contact it is believed that any small amount that drifts away to some neighbouring crop will not cause more than slight superficial burning around the point of contact.

As it is rapidly decomposed in the soil and there is no danger to crops following the potatoes, in fact the land can be ploughed and resown immediately after lifting the potatoes.

Future prospects

Investigations into the possible use of this most interesting chemical in other fields of weed control, are being continued and it can be assumed that Imperial Chemical Industries would not have continued to develop diquat without there being a distinct possibility that other outlets will be discovered.

Colonial Spraying Machine Centre

On 28th June the Silwood Park Colonial Spraying Machinery Centre held an Open Day, mainly to show off their new building in which the machinery will be housed and tests on spraying machines carried out. The building which has a floor area of about 4,200 square feet is unpretentious but efficient and has distinct advantages over the Nissen hut which previously served for housing the machinery. Moreover, in the new building tests can be carried out during the winter whereas in the old, condensation problems severely hampered winter activities.

Funds for the building for the most part were provided by the Colonial Office and the Shell International Company. Both bodies will contribute the lion's share of the money for the future running of the Centre. The Staff, however, will mainly be provided by the Imperial College of Science and Technology.

Purpose

Chemicals in the form of sprays, mists, aerosols, smokes, dusts, etc., are used on an increasing scale throughout the world to combat diseases and pests in the field of agriculture, stored products, forestry, public health, hygiene and medicine. Naturally this great variety of uses necessitates the use of numerous types of machinery and anyone who will have occasion to use sprays and spraying machines must have an adequate background knowledge of new and proved techniques, in order to obtain full benefit from the use of pesticides. Realising this the Imperial College set up the Spraying Machinery Centre in 1955 to instruct its own students in the use of spraying and dusting machines. However, as Professor Richards, Director of the Field Station and Dr. Galley, Director of the Colonial Pesticides Research Unit, pointed out, it was soon appreciated that the centre had far greater possibilities and following discussions with the Colonial Office and the Agricultural Engineers Association the Imperial College decided to set up a comprehensive demonstration of spraying machinery for the benefit of overseas students and users. In addition formal courses of instruction in the principles of the application of sprays and dusts are held for Officers of Colonial Governments who are nominated for this training. These courses are held twice a year and are normally arranged so that officers from overseas territories can attend whilst they are on vacation.

Another important function of the centre—backed by W.H.O. and spraying machine manufacturers—is the testing of spraying machines. Among the tests to be seen at the demonstration was a 'hose testing device' in which the rubber used in spraying machines could be artificially aged by means of solvents, etc., and tested for elasticity and breaking point; 'a valve distribution test' in which a nozzle is placed above a corrugated sheet, liquid ejected from the nozzle falls on the sheet and runs down the furrows into graduated collecting vessels at the end of each furrow, by comparison of the amount of liquid collected in each vessel the volume distribution can be calculated. Other tests included an 'accelerated fatigue test' consisting of apparatus designed to test the strength of the sprayer cylinder by the application of 12,000 cycles of compression and decompression; a 'cut off valve tester' which opens and closes the trigger valve some 50,000 times at a rate of 12 per minute; there is a 'drop test' designed to test the effect on the strap, cylinder and other external parts, of such accidents as dropping or rough handling in practical use, yet another test determines the resistance of nozzles to erosion.

Manufacturer's part

Needless to say these activities could not be carried out without an adequate supply of machines of all types. Many manufacturers have loaned machines to the centre and have also provided it with a comprehensive library consisting of technical literature and coloured slides. Mr. Perch, Director of Kent Engineering and Foundry Ltd., honestly admitted this was not purely a philanthropic gesture on the part of manufacturers for besides the benefit of having their machines independently tested they also receive valuable publicity. Visitors to the Centre from the country and overseas will be able to select the type of machine he requires for his own use and from the demonstration and literature he will be able to find the names and addresses of the manufacturers producing the type of machine he has selected.

All told the Centre provides an excellent example of mutual co-operation leading to mutual benefit.

PEOPLE

New Chairman for the Advisory Committee on Poisonous Substances

The Minister of Agriculture, Fisheries and Food, in consultation with the other Ministers concerned, has appointed Sir Charles Dodds, M.V.O., F.R.S., D.Sc., Ph.D., M.D., F.R.C.P., F.R.I.C., F.R.S.E., to be Chairman of the inter-departmental Advisory Committee on Poisonous Substances used in Agriculture and Food Storage. Sir Charles, who succeeds Sir Solly Zuckerman as Chairman of this Committee, is Courtauld Professor of Biochemistry in the University of London. He has served since 1951 as the Chairman of the Preservatives Sub-Committee of the Food Standards Committee.

The Committee, appointed in March 1954 to keep under review all risks that may arise from the use of toxic substances on agricultural products and in the storage of food and to make recommendations to the Ministers concerned, was recently reconstituted to include the following five members from outside the Government Service, each of whom is a specialist in one of the fields covered by the Committee:

Professor J. H. Gaddum, F.R.S., F.R.S.E., Sc.D., M.R.C.S., L.R.C.P., Director of the Institute of Animal Physiology, Cambridge.

Professor Andrew Wilson, M.D., Ph.D., F.P.S., F.R.F.P.S., Professor of Pharmacology, Liverpool University.

Dr. J. Hamence, M.Sc., Ph.D., F.R.I.C., Public Analyst and Agricultural Analyst.

Mr. F. H. Garner, M.A., M.Sc., Principal of the Royal Agricultural College, Cirencester.

Professor A. R. Clapham, M.A., Ph.D., F.R.S., Professor of Botany, Sheffield University.

I.P.C.A. Officers for 1960/61

The following were elected as Officers and Executive Committee of the Industrial Pest Control Association for the year 1960/61:-

President:

Mr. D. J. S. Hartt, May & Baker Ltd.

Vice-President:

Mr. G. A. Campbell, The Geigy Co. Ltd.

Hon. Treasurer:

Mr. S. Farrow, London Fumigation Co. Ltd.

Executive Committee:

Mr. D. Boocock,
Standardised Disinfectants Co. Ltd.

Dr. F. P. Coyne,
Imperial Chemical Industries Ltd.

Mr. S. R. Gauntlett,
Disinfestation Ltd.

Mr. D. M. Simpson,
Cooper McDougall & Robertson Ltd.

Mr. H. D. H. Womack,
Shell Chemical Co. Ltd.

Hon. Auditors:

Mr. W. H. Comerford, W. Edmonds & Co. Ltd.

Mr. S. P. Egleton, Verminex Ltd.

Secretary:

Mr. W. A. Williams, M.B.E.

New Appointments to the Pyrethrum Board of Kenya

Mr. J. F. Perkins, a member of the Pyrethrum Board of Kenya since 1956, has been elected Vice-Chairman.

Mr. Perkins, who farms near Kitale, was formerly General Manager of the Magadi Soda Company, Kenya, (an I.C.I. subsidiary). He replaces Mr. R. T. Mytton Watson who resigned in March.

There are now two African members of the Board. Mr. Isaac Kuria, representing African farmers in the Eastern districts of the pyrethrum growing area, has been a member of the Board since January 1959. Now Mr. Justin Masese Mochache has been elected an additional African member to represent African growers in the Western districts.

NEWS

Pesticides—Changes in the Regulations for Protecting Farm Workers

Three new chemicals—endothal and its salts, "Gusathion" and phosphamidon—have been added to the Regulations for the protection of workers who use poisonous substances in agriculture.

This means that agricultural workers using any of these chemicals must observe the specified precautions, including the wearing of the protective clothing appropriate to the particular category, and to the particular circumstances in which the chemical is used.

Endothal and its salts, and "Gusathion" become Part II substances, and phosphamidon a Part III substance under the Agriculture (Poisonous Substances) Regulations, 1956—1960.

Designs for Pesticide Containers

The Metal Box Company Ltd. have recently been designing packs for pesticide manufacturers. Among the recent packs designed by the Company's studios are the "O-Cedar Fly-Spray" containers.

The "flit-gun" sprayer, refills and aerosol have all been given a family likeness; the containers are in four colours printed directly on tinplate by the offset lithographic process.

The International Toxin Products' liquid fertilizer mixing kit has also been designed by Metal Box, the outer cardboard pack slide carton being supplied by the Company's Paper Products group whilst the three stock 4 oz. poly-tainers containing nitrogen, phosphates and potash are suppled by the Plastics Group of the Metal Box Co. Ltd. the unbreakable polythene containers have polyurea caps and are embossed with the I.T.P. trade mark and name of contents.

Metal Box's bottles and laminated packets for fertilizers and insecticides will be on show at the Royal Show.

Taste of Death

Scientists of the Alabama Polytechnic Institute are reported to have devised a novel method of dealing with the fire ant, which is a serious pest in certain areas of the Southern United States. 100% kills have been obtained in field trials using a mixture of peanut butter, which apparently the ants cannot resist, and kepone, a slow acting stomach poison known chemically as decachloro-octahydro 1, 3, 4-metheno-2H-cyclobuta [cd] pentalene-2-one.

Using a grease gun, the mixture is packed into straws, which are then cut into thirds and broadcast over ant infested pastures. The fire ants attracted by the peanut butter rapidly clean out the straws and carry the mixture back to their mounds. The immature insects are the first to die. Then follow the small workers, the major workers and the winged ants.

The effects of this method on wild life are now being studied but it is expected to prove less dangerous to wild life and domestic animals than other fire ant control methods. Firstly the ants give other animals only a brief chance at the poison and in short lengths the straws do not attract livestock. Costs should be low.

Low Priced Garden Aerosol

Durazone-Choice Products are to market a low priced 6 oz. aerosol for use as a garden spray. The "Choice" garden spray is for outdoor or greenhouse use. It is claimed that a fine surface film of insecticide, lethal to aphids, capsids, thrips and all other species of common garden pests, is left on the plant.

It can be safely used on all flowers and plants, except ferns. In addition food crops except Marrows, melons and cucumbers, can be treated providing the crop is not harvested within 7 days.

More Radio Isotopes Used in Pesticide Research

In the June issue of *ATOM* the Information Bulletin of the United Kingdom Atomic Energy Authority it is reported that although carbon-14 is still the most powerful isotope for tracer work, the demand for labelled compounds containing other isotopes has increased greatly. Amongst the labelled compounds synthesized are over seventy organic compounds containing phosphorous—32 including the insecticides, schradan, systox, T.E.P.P., amiton, parathion and Thimet.

PUBLICATIONS RECEIVED——

Transactions of the 1st International Conference of Insect Pathology and Biological Control, Praha 1958.
Published by the Czechoslovak Academy of Sciences, Prague. Obtainable from Artia, Foreign Trade Corporation, P.O.B. 790 Prague, Czechoslovakia, Price, Kcs 56-.

The publication is a record of the above conference which was the first meeting of its kind and which was attended by representatives of 17 nations. The papers presented gave a description of the use of bacteria, viruses, protozoa, rickettsiae, nematodes, etc., against pests of agriculture, forestry and public health, in various parts of the world. Associated problems such as mass cultivation of parasites, international organization etc., were also discussed.

Lectures are printed in the language in which they were read or sent for print. Discussions are reproduced in the same way. Headings and several articles of general interest are in both English and Russian, the Conference's Resolution is also printed in German. Lectures published in Western languages have Russian summaries and vice-versa.

The transactions are split into two sections dealing respectively with Insect Pathology and Biological control. Each section is further divided into symposia. Symposia in the first section are:-

(1) *Insect Bacteriology.* In this symposium interesting papers include "Bacteria as Microbial Control Agents" by E. A. Steinhaus who discussed the parts played by various species of bacteria as biological control agents, concluding that the sporeforming bacteria, especially crystalliferous species and those containing parasporal bodies, demonstrate the greatest potentiality for use as microbial control agents. This latter statement was supported by other papers in this symposium notably "The Biological Character of Some Entomopathogenous Bacteria and their Practical Use" by O.I. Schvetzova (Paper in Russian, English Summary) and "Bacterial Control of Dendrolimus Sibiricus" by E. V. Talalayev (Paper in Russian, German Summary). Other papers in this symposium which deserve extra notice are "Ecology of Microorganisms in Biological Control of Insects" by O. Lysenko and "Serodiagnosis of Diseases of the Honeybee and Other Insects" by V. I. Poltev (the last paper in Russian with German Summary).

(2) *Insect Mycology*

The leading paper in the symposium is "The Use of Entomophagous Fungi together with Insecticides in Insect Control" by N. A. Telenga (Language, German).

(3) *Insect Virology*

Two very interesting papers "Some topics of Insect Virology" by G. H. Bergold and "A Polyhedrosis Virus for Control of the Great Basin Tent Caterpillar" by G. G. Thompson (both in English) highlight this section of biological control which, however, still contains many problems to be solved.

(4) *Insect Protozoology and Helminthology*

Two papers by J. Weiser on the Taxonomy of Microsporidia and a Nematode Parasite of *Melolontha Melolontha* are included (language, German) P. C. Garnham refers to some protozoan parasites of Mosquitoes. It appears that Nematode parasites of insects should be further studied.

In Section 2.—Biological Control is dealt with in the following symposia.

(5) *Taxonomy of Entomaphagous Insects*

Papers by N. A. Telenga, Lubomir Masner and Milorad Tadic are in English, discussion of the symposium is published in German.

(6) *Evaluation of Results of Introductions*

(7) *Rise of the Effect of Parasitic Insects*

The main paper by V. A. Shepetilnikova gives an account of the use of Parasites in insect control in the Soviet Union (Paper in Russian, English Summary). The possibility of producing more efficient parasites by hybridization is mentioned in this symposium which also includes a paper by L. P. Mensil who concludes that more attention should be paid to the possible use of polyvalent parasites and predators.

(8) *Monophagous and Polyphagous Insects*

Papers in English on "Monophagy versus Polyphagy" by Liu Chnng-Lo, "Ecology of Aphidophagous Coccinellidae" by I. Hodek and "Natural Enemies of the Bean Aphid" by Hodek *et al.*

(9) *International Problems of Co-operation in Biological Control*

The need for further international co-operation is stressed in all papers.

Pharmacy and Poisons Act 1933 and Poisons Rules 1960
Relating to the Sales of Insecticides, Fungicides, Weedkillers and Rodenticides
Published by the Association of British Manufacturers of Agricultural Chemicals, 86 Strand, London, W.C.2 Price 3/- post free

This booklet replaces and brings up to date the chart, formerly issued by the Association, and will be of considerable interest to anyone selling pesticides.

It gives an account of the procedure to be followed when making wholesale sales, retail sales and sales to growers, of some 60 scheduled compounds. Copies of the Booklet may be obtained from the Association.

Control of White Grubs in Eastern Canada.
By G. H. Hammond, published by the Research Branch of the Canada Department of Agriculture. Publication No. 1069.

In this leaflet an account of the life cycle and economic importance of the June beetles (*Phyllophaga*) is given. It contains the information that in Eastern Canada losses due to the white grubs during the past 50 years have amounted to many thousands of dollars. White grubs are mainly a problem in sandy or sandy loam soils and severe damage usually occurs in the year after the eggs are laid, so that in Eastern

Canada severe damage occurs every third year. Recommendations are given for control by crop rotation and tillage, control in permanent turf or sod, control in plant nurseries, control on mixed farms and control in strawberries.

Fomes annosus in Great Britain An assessment of the situation in 1959 Forestry Commission Forest Record No. 41. *By J. D. Low and R. J. Gladman*
Published by H.M.S.O. London, price 4/-.

This Record deals mainly with the spread and development of butt rot disease and discusses measures to limit its further increase. In giving an account of the background to the present problems. The authors describe "Butt- or Root-rot" caused by *Fomes annosus* as the most serious tree disease in Britain and several other European countries. They also give accounts of, the factors involved in infection and development of the present position in Britain in relation to previous forest history, and the mechanism of infection. Other aspects which are considered include evidence that attack increases in successive rotations, evidence of the spread of infection into new areas, the effect of species and site on attack and crop protection methods.

In conclusion the authors state that:-

"If no measures are taken, *Fomes* infection will establish itself through most of our new conifer plantations and will become the cause of widespread and serious loss.

"Progressive increase is a consistent feature of *Fomes* butt rot attack.

"It is, therefore, desirable to assess the present status and future danger of *Fomes* in each forest or estate. On our present knowledge it is considered that the adoption of stump treatment as a general measure of crop protection would be justifiable in all conifer plantations *except* those that previously carried pure hard wood crops or those where there is wet, acid peaty soil."

Foresters will find this leaflet a useful addition to their Library.

The Large Pine Weevil. Forestry Commission Leaflet No. 1.
Published by H.M.S.O. London. Price 1/-

This excellently produced leaflet gives an account of the large pine weevil(*Hylobius abietus*) its life cycle, habits, damage caused and control methods. Methods for distinguishing the genus *Hylobius* from the closely allied genus *Pissodes* are also given.

The Grey Squirrel—A Woodland Pest. Forestry Commission Leaflet No 31. Second Edition.
Published by H.M.S.O. London, Price 1/6.

An excellent example of the Forestry Commission's delightful leaflets. It is interesting, instructive and well written. The leaflet describes the grey squirrel, its habits, life history, distribution, feeding habits and the damage that it causes. Advice on the various methods of controlling this pest are given as are the names of the manufacturers of the recommended traps.